REMARKS

Applicants have amended their claims to further define various aspects of the present invention. Specifically, Applicants have amended each of claims 3 and 7 to recite that the apparatus further includes shower holes provided between an outlet of the gas introducing means and the plasma generated. Note, for example, Fig. 2, and the description in connection therewith in the paragraph bridging pages 11-13 of Applicants' specification.

In addition, Applicants are adding new claims 8-12 to the application. Of these newly added claims, claim 10 recites the same subject matter as set forth in claim 5, but is dependent on claim 7; and claims 8, 9, 11 and 12, dependent respectively on claims 3, 5, 10 and 7, recite that the temperature control mechanism for the substrate stage provides temperature control of the substrate, whereby etching rate and etching shape in the substrate surface can be made uniform. Note, for example, page 12, lines 3-18, of Applicants' specification.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the references applied by the Examiner in rejecting claims in the Office Action mailed August 10, 2005, that is, the teachings of U.S. Patent No. 5,846,373 to Pirkle, et al., and European Patent Application No. EP 709 877 (Saito, et al.), under the provisions of 35 USC 103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a plasma etching treatment apparatus as in the present claims, for conducting etching in at least two steps and providing cleaning without conducting a separate cleaning step, and wherein the apparatus includes, inter alia, a gas introducing means, a temperature

control mechanism for the substrate stage, and shower holes provided between an outlet of a gas introducing means and the plasma generated, with the gas introducing means introducing a treating gas (a) for etching and a treating gas (b) for decomposing and removing etching products, into the etching treatment room, the semiconductor substrate being etched using plasmas obtained from each introduced treating gas in each step, while the treating gas (b) removes etching products retained in the etching treatment without conducting a separate cleaning step (see claim 3); or wherein the gas introducing means introduces different gas compositions in each step of the at least two steps in which etching is conducted, at least one of the gas compositions being a gas capable of decomposing and vaporizing etching products, and the semiconductor substrate being etched by plasmas obtained from the different gas compositions of the at least two steps, etching products produced by a previous etching treatment being removed without conducting a separate cleaning step (see claim 7).

In addition, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such plasma etching treatment apparatus having features as discussed in the foregoing in connection with claims 3 and 7, and, moreover, wherein the apparatus further includes an electrostatic adsorption device to hold the semiconductor substrate on the substrate stage (see claims 5 and 10); and/or wherein the temperature control mechanism for the substrate stage provides temperature control of the substrate, whereby etching rate and etching shape in the substrate surface can be made uniform (see claims 8, 9, 11 and 12); and/or wherein the gas introducing means includes a source of the treating gas for decomposing and removing etching products and a source of the treating gas for etching (see claim 4); and/or wherein

the apparatus is adapted to discharge charges stored between the substrate stage and a semiconductor substrate placed thereon, with the gas introducing means introducing the treating gas, for decomposing and removing etching products, into the etching treatment room, when the charges are discharged (see claim 6).

The invention as claimed in the above-identified application is directed to apparatus for effectively etching a semiconductor substrate and effectively removing etching products retained in the treatment apparatus, providing a cleaning effect of the apparatus during the etching, without the need of a separate cleaning step of the plasma etching treatment apparatus, whereby a disadvantageous effect on productivity can be avoided. The presently claimed apparatus is especially useful in connection with manufacture of recent semiconductor devices having higher integration, wherein circuit patterns become finer and finer to make requirement for processing dimensional accuracy more severe; and wherein, under such circumstances, reproducibility of the processed device becomes even more important.

In such recent fine devices, it becomes more important to have accuracy in the etching shape in the substrate, and to have a reproducible etching shape, and it is also important to remove etching products (contaminants) retained in the processing chamber, these etching products being an important cause of defective semiconductor products. Various techniques have been proposed to remove the etching products, as described on pages 2 and 3 of Applicants' specification; however, such proposed techniques either do not address the problem of shift of etching ability due to retention of deposited material on the apparatus, or requires substantial "down time" (a time when the apparatus is stopped from processing substrates), which disadvantageously effects productivity. See the last full

paragraph on page 2, and the paragraph bridging pages 2 and 3, of Applicants' specification.

Against this background, Applicants provide etching treatment apparatus which can provide the etching shape with excellent reproducibility over time and which also removes etching products such that the contaminant level does not exceed a predetermined amount, while avoiding "down time"; and wherein etching rate and etching shape are uniform over the substrate surface. Applicants have found that by utilizing the temperature control mechanism for the substrate stage, which, in particular, provides temperature control of the substrate, and by providing the shower holes between an outlet of the gas introducing means and the plasma that is generated during operation of the apparatus; and, moreover, providing the etching/cleaning as in the present claims, objectives according to the present invention are achieved, and, in particular, etching rate and etching shape are made uniform. Note, in particular, page 12, lines 2-20 of Applicants' specification.

More specifically, in the case of a step of generating a large amount of reaction products which are adhered in the treatment room, these reaction products are decomposed and removed by a following step which generates a small amount of reaction products. For example, reaction products generated by the main etching are removed by a next step such as an overetching step or deelectrifying step of an electrostatic chuck, which step also functions for cleaning. In such a case, the decomposed reaction products are deposited on the wafer again. Since the overetching and deelectrifying steps are conducted under conditions which hardly etch the substrate, the redeposition of the reaction products on the wafer disadvantageously influences the etching shape. Thus, it becomes necessary to control the temperature of the substrate stage, so as to remove influence of

redeposition on the wafer. According to the present invention, utilizing etching apparatus having the temperature control mechanism and the shower holes, influence of redeposition is avoided.

Saito, et al. discloses a plasma processing method and apparatus suitable for etching a wafer while holding the same on an electrode by electrostatic force, and using hydrogen bromide as an etching gas. This patent document discloses, according to one aspect thereof, that after completion of etching of the wafer having the same wafer as electrostatically chucked on the electrode, O_2 gas instead of the etching gas is introduced into the chamber to generate a plasma of O_2 gas, whereby not only the residual electric charge on the wafer resulting from the electrostatic attraction can be deelectrified but also cleaning of the interior of the chamber can be conducted at the same time by causing C and H which are the main components of the reaction product deposited inside the chamber to react with O_2 and to be removed. See column 2, lines 14-31. Note also column 3, lines 15-27 and 37-43; and column 4, lines 3-11.

It is respectfully submitted that Saito, et al. discloses a cleaning treatment which is conducted separately from the etching treatment, after completion of the etching. That is, the cleaning with the O_2 plasma is not an etching treatment. It is respectfully submitted that this reference would have neither disclosed nor would have suggested, and in fact would have taught away from, the presently claimed apparatus, including wherein the gas introducing means introduces different gas compositions in each step of at least two steps, at least one of the compositions being a gas capable of decomposing and vaporizing etching products; and the semiconductor substrate is etched by using plasmas obtained from the different gas compositions of the at least two steps, with, e.g., etching products produced by a

previous etching treatment being removed without conducting a separate cleaning step.

That is, while the present invention includes gas introducing means wherein the substrate is etched using plasmas obtained from the different gas compositions at the various steps, so that the apparatus is utilized without conducting a separate cleaning step, Saito, et al. requires a separate cleaning step using the O_2 gas therein.

In addition, it is respectfully submitted that Saito, et al. would have neither taught nor would have suggested the temperature control mechanism for the substrate stage and the shower holes, as in the present claims, and advantages thereof as discussed in the foregoing. Note each of claims 3 and 7.

It is respectfully submitted that the additional teachings of Pirkle, et al. would not have rectified the deficiencies of Saito, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Pirkle, et al. discloses methods and arrangements for monitoring silicon dioxide deposition and in-situ cleaning process endpoints in plasma chambers. In the method disclosed by Pirkle, et al., an SiO_2 deposition is performed on a semiconductor substrate; and an

in-situ cleaning process is performed on the plasma chamber, subsequent to the SiO_2 deposition. The in-situ cleaning process includes steps of generating a fluorine-containing etching plasma in the plasma chamber so that the etching plasma reacts with SiO_2 in the plasma chamber to form a plurality of reaction products; filtering light emissions from the plasma chamber with a wavelength selective element so that one of the reaction products having a characteristic wavelength proximate the peak transmission of the wavelength selective element is transmitted through the

wavelength selective element; monitoring, with a photodetector, emission intensity of light emitted by one of the reaction products; measuring voltage output from the photodetector, the voltage output being proportional to the amount of the reaction product in the etching plasma; and stopping generation of the etching plasma when voltage measurements decrease to a substantially steady state value. Note column 2, lines 22-56. See also column 3, lines 26-51, in connection with the described apparatus. Note also column 4, lines 41-45.

Even assuming, arguendo, that the teachings of Saito, et al. and Pirkle, et al. were properly combinable, it is respectfully submitted that the combined teachings of these references would have neither disclosed nor would have suggested the presently claimed apparatus, including the temperature control mechanism and shower holes, especially together with the electrostatic adsorption device, and advantages thereof in providing etching shape uniformity; and particularly together with the gas introducing means, and particularly wherein the semiconductor substrate is etched using plasmas obtained from each introduced treating gas in each step, while the treating gas (b) removes etching products retained in the etching treatment room without conducting a separate cleaning step, especially where etching products from a previous etching treatment are removed without a separate cleaning step; and/or the monitoring means for monitoring a retained amount of etching products and being controlled so as to stop each plasma discharge automatically at the recited time.

As described in Pirkle, et al., and consistent with the teachings of Saito, et al., a separate cleaning step is required. It is respectfully submitted that the combined teachings of Saito, et al. and of Pirkle, et al. would have neither taught nor would have suggested, and in fact would have taught away from, the presently claimed

apparatus for conducting etching in at least two steps and without conducting a separate cleaning step, including, inter alia, the gas introducing means for introducing the respective treating gases for etching and for decomposing and removing etching products, with the substrate being etched using plasmas obtained from each introduced treating gas in each step (see claim 3); and/or wherein the gas introducing means introduces different gas compositions in each step of the at least two steps, the semiconductor substrate being etched by plasmas obtained from the different gas compositions of the at least two steps, with etching products produced by a previous etching treatment being removed without a separate cleaning step (see claim 7).

It is noted that Pirkle, et al. uses a wavelength selective device for monitoring the deposition and cleaning process; but it is respectfully submitted that this reference does not disclose, nor would have suggested, either by itself or in combination with the teachings of Saito, et al., controlling the monitoring means so as to stop each plasma discharge automatically as in the present claims.

It is emphasized that Pirkle, et al. discloses a monitoring system, including, inter alia, temperature monitoring equipment 28 attached to temperature probe 29 (note Fig. 1B). It is respectfully submitted that disclosure of such monitoring equipment would have neither taught nor would have suggested the temperature control mechanism for the substrate stage as in the present invention, including advantages of the temperature control mechanism of the present invention as discussed previously.

As can be appreciated, Pirkle, et al. discloses cooling with water, disclosing lowering of the temperature. In contrast, according to the present invention, a temperature control mechanism is included, which controls the temperature whereby

not only can the temperature be lowered but also the temperature can be raised, where desirable. Through use of the temperature control mechanism in combination with other features of the present invention, desired cleaning is achieved whereby redeposition of reaction products can be avoided. Clearly, Pirkle, et al., either alone or in combination with the teachings of Saito, et al., would have neither disclosed nor would have suggested the present invention, including the temperature control mechanism as in the present claims, whereby etching rate and etching shape in the substrate surface can be made uniform. See especially claims 8, 9, 11 and 12. In this regard, it is respectfully submitted that the "whereby" clause in claims 8, 9, 11 and 12 must be given weight in determining patentability of presently claimed subject matter. See Plastic Container Corp. v. Continental Plastics of Oklahoma, Inc., 203 USPQ 650 (CA10 1979).

Reference by the Examiner in the last paragraph on page 5 of the Office Action mailed August 10, 2005, to "art related to [the] functional limitation", the Examiner contending that prior art is known to disclose a "process for multi step etch without separate cleaning step", is noted. Apparently, the Examiner has referenced U.S. Patent No. 6,699,399 to Qian, et al. as disclosing a multi step etch with cleaning step built in, without resorting to a separate cleaning step. Note also the first paragraph on page 6 of the Office Action mailed August 10, 2005. If the Examiner intends to rely on Qian, et al. in a rejection of the claims, for establishing what is known in the prior art, it is respectfully submitted that this reference must be set forth as part of the formal rejection, with, e.g., motivation for utilizing the teachings thereof set forth. See In re Hoch, 166 USPQ 406, 407n. 3 (CCPA 1970).

The Examiner contends in the last paragraph on page 4 of the Office Action mailed August 10, 2005, that claims directed to apparatus must be distinguished

from the prior art in terms of structure rather than function. However, it is again noted that a "whereby" clause must be given weight in determining patentability, as expressly set forth in Plastic Container Corp. v. Continental Plastics of Oklahoma, Inc., supra. Moreover, apparatus such as the temperature control mechanism and shower holes constitute components which clearly must be given weight in determining patentability.

In addition, the present claims recite specified gas introducing means, in each of claims 3 and 7. It is respectfully submitted that such means defines structure, and must be considered in determining patentability of the claimed apparatus.

The contention by the Examiner that the particular type of gas used is a process limitation rather than an apparatus limitation, set forth in the first paragraph on page 5 of the Office Action mailed August 10, 2005, is noted. It must be emphasized, however, that Applicants are not claiming a gas, but rather are claiming a gas introducing means, which must be considered in a determination of patentability of the claimed apparatus.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently pending in the above-identified application are respectfully requested.

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Respectfully submitted,

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